Traffic Planning and Operation

CIV ENG 794

DEPARTMENT OF CIVIL ENGINEERING
UNIVERSITY OF WISCONSIN – MILWAUKEE

Spring 2017

JIE YU, Ph.D.
Assistant Professor

UNIVERSITY of WISCONSIN
UWMILWAUKEE

RESEARCH INTERESTS

I. Public Transportation Planning and Development

GRANTS:

(2016) TCRP Topic SA-42, College Student Transit Pass Programs, National academy of Sciences

(2015) A Smartphone-based Surveying System for Transit Data Collection, MOBILETRANS TECHNOLOGY

(2014) Strategies to Improve Public Transit Ridership in Jinan City, Global Energy Foundation, The World Bank

(2013) Jinan Transit Metropolis Strategic Planning, Jinan Transport Bureau, China

(2012) Responsive Demand Transit Service: Traveler Willingness and Feasibility Study in Jinan City, Jinan Transport Bureau, China

(2011) Cluster-based Location Planning for Urban Transit Hubs, ***National Natural Science Foundation of China***

(2007) Urban Transportation Network Optimization and Management, National Natural Key Science Foundation of China…

RESEARCH INTERESTS

II. Multi-modal Transportation System Design

GRANTS:

(2011) Network Design of Transit Transfer Centers, Natural Science Foundation of Shandong Province, China

(2010) A Multi-modal Evacuation System for Baltimore, Maryland, The United States Department of Homeland Security, D.C., USA

(2007) TOD based Public Transportation Hub Design for Tianjin City, Tianjin Planning Bureau, China

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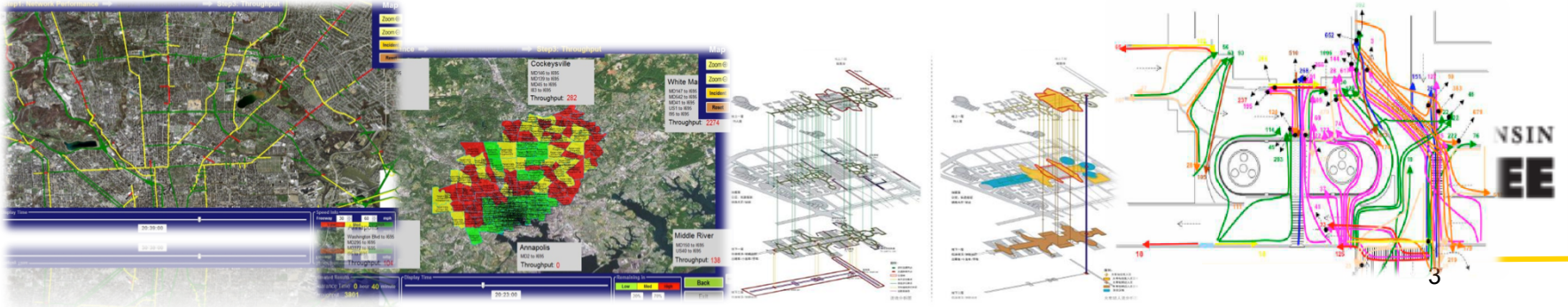

RESEARCH INTERESTS

III. Integrated Urban Transport Corridor Planning and Design

GRANTS:

(2014) Afghanistan: Kabul Urban Transport Efficiency Improvement (KUTEI) Project, The World Bank

(2014) China: Henan Jiaozuo Urban Transport Project, The World Bank

(2013) China: Yunnan Honghe Prefecture Urban Transport Project, The World Bank

(2012) Comparative Study of Integrated Urban Transport Corridor Alternatives in Jinan City, Jinan Municipal Government

(2011) China: Changzhi Sustainable Urban Transport Project, The World Bank

(2011) China: Linfen Sustainable Urban Transport Project, Global Energy Foundation

RESEARCH INTERESTS

IV. Road Safety Analysis and Assessment

GRANTS:

(2013) China Children Road Safety Project, joint project by Global Red Cross Association and China NDRC

(2010) Modeling Review and Enhancement for Crash Analysis and Prediction: Phase II- Enhanced Methodology to Identify and Rank High Accident Locations for Safety Improvement on Public Roadways, Maryland State Highway Administration, USA

(2009) Modeling Review and Enhancement for Crash Analysis and Prediction: Phase 1-Evaluation of Current Accident Studies and Analysis Standard Operating Procedures (SOPs) in Maryland, Maryland State Highway Administration, USA

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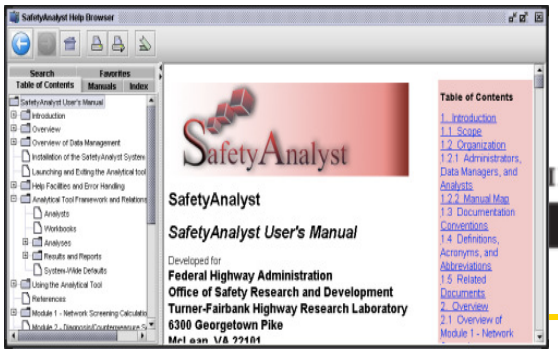

Public Transport Planning and Operation

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Course Overview

Course Description

- A comprehensive analysis of the planning, design and operation of public transportation systems in urban settings, including
  - collecting, by-hand or from existing sources, data to measure transit performance;
  - quantifying changes in capacity and reliability caused by changes in ITS and right-of-way;
  - quantifying route-level transit service characteristics;
  - describing factors influencing transit ridership and analyzing/ predicting demand for service in a region;
  - selecting transit routes that meet the needs of the ridership; and
  - scheduling vehicles and crews to maximize transit productivity

Course Readings

- This course relies on a number of materials, especially:
  - Kittelson & Associates, Inc. *et al.* (2013) "TCRP Report 165: Transit Capacity and Quality of Service Manual, 3rd Edition", *Transportation Research Board.*
  - Jarrett Walker. (2011) "Human Transit: How Clearer Thinking about Public Transit Can Enrich Our Communities and Our Lives", *Island Press.*
  - Latest edition of the American Public Transportation Association. "Public Transportation Fact Book", *American Public Transportation Association.*
  - Hickman, Mark, "Fundamentals of Transportation" wikibook, http://en.wikibooks.org/wiki/Fundamentals_of_Transportation/

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Course Syllabus

- Class Schedule: Tu 5:30PM – 8:10PM EMS W110
- Instructor: Dr. Jie Yu (yu22@uwm.edu)
- Office: NWQ 4428
- Office Hours: Tu 4:30PM – 5:30PM or by appointment

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Course Syllabus

- Homework

1. Due at the beginning of the class in each week following the assignment

2. A 20% penalization is applied for late homework

3. Electronic submissions are OK via D2L, but HARD COPIES are preferred

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Course Syllabus

- Grading Policy

Final Grade will be based on:

• Homework	30%
• Term paper	50%
• Class Participation/Communications	20%
Total	100%

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Grading Policy

The grade of term paper will be based upon the following criteria:

• Objectives appropriate and clearly stated:	10%
• Methodology technically sound:	10%
• Data valid:	20%
• Conclusions valid and properly supported:	20%
• Study effort adequately described:	20%
• Report organization:	10%
• Well written and easily understood:	10%
	100%

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01 Introduction

What is "transit"?

Simple Answer:

Collective Transportation

But why do we have to travel collectively in urban space?

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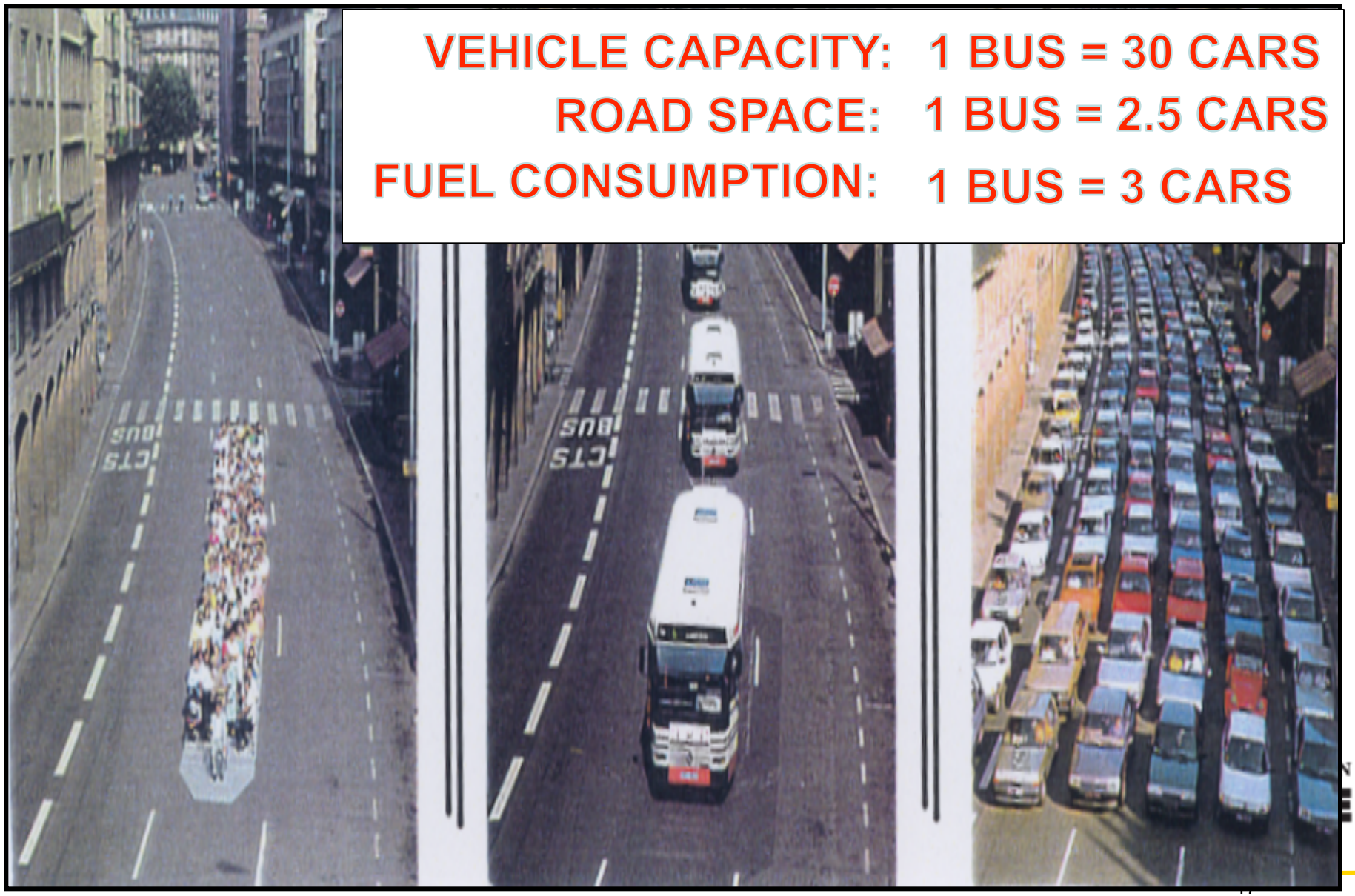
GOAL: TO MAXIMIZE SPACE

VEHICLE CAPACITY: 1 BUS = 30 CARS

ROAD SPACE: 1 BUS = 2.5 CARS

FUEL CONSUMPTION: 1 BUS = 3 CARS



Transit Mode Definition

4 Basic Characteristics:

- Right-of-Way (ROW)
- System Technology
- Types of Service
- Organizational Oversight

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Examples of ROW Classes

- Class A: Boston Red Line

- Class B: Dublin Light Rail

- Class C: MARTA Bus

Pros and Cons of Rights of Way

ROW A

+ Highest performance
+ Electric guided technology
+ High safety
+ Short dwell time
- Highest investment cost
- Rigid alignment
- Grade-separated stations require land and longer access

ROW B

+ Higher performance – speed, reliability, capacity, comfort, safety
+ Use of longer vehicles
+ Stronger identity / image
+ Lower per passenger operating cost
+ Can be electrified
- Require space for ROW
- Higher investment
- Special signals or control / priority measures

ROW C

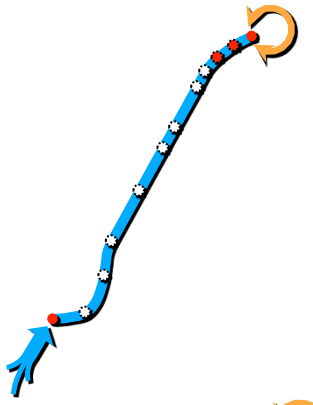
Characteristic 2: System Technology

Support: Vertical contact	Guidance: Lateral control	Propulsion: Power system	Control: Spacing
• Rubber tire on pavement • Steel wheel on rail • Vehicle on water, mag lev, etc.	• Steered by driver • Guided by track	• Diesel engine • Electric motor • Hybrid • Magnetic forces, etc	• Manual/visual • Manual/ signals • Automatic

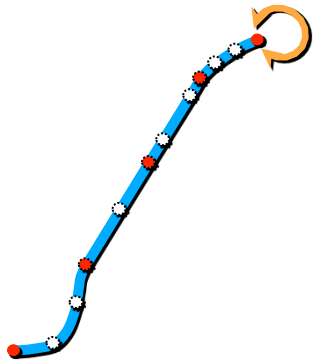
Characteristic 3: Types of Service

- Trip Served
  - Short-haul
  - City transit
  - Regional transit
- Time of Day
  - Regular
  - Peak
  - Special
- Stopping Schedule

Express



Rapid



Local

Characteristic 4: Organization Oversight

On-Demand Individuals

On-Demand Group

Characteristic 4: Organization Oversight

Public Group

Characteristics of Organizational Oversight

Characteristic	Private		On-Demand		Public
Designation	Private		Paratransit		Transit
Availability	Owner		Public		Public
Supplier	User		Carrier		Carrier
Route determination	User (flexible)		User	User (carrier)	Carrier (fixed)
Time-schedule determination	User (flexible)		User	User (carrier)	Carrier (fixed)
Cost-price	User absorbs		Fixed RATE		Fixed FARE
Carrier type	Individual	Group	Individual	Group	Group
Modes	SOV	Carpool	Taxi	Dial-a-ride	Street transit
	Motorcycle	Vanpool	Rent Car	Jitney	Semirapid transit
	Bicycle		Car Share	Charter	Rapid Transit
	Walking		Bike Share		Specialized

This classification of usage leads us to our

FAMILIES OF TRANSIT MODES

4 Major Transit Families

- Street Transit
  - Right-of-Way (ROW)
  - System Technology
  - Types of Service
- Rapid Transit
  - Right-of-Way (ROW)
  - System Technology
  - Types of Service
- Semi-rapid Transit
  - Right-of-Way (ROW)
  - System Technology
  - Types of Service
- Specialized Transit
  - Right-of-Way (ROW)
  - System Technology
  - Types of Service

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COMPARISON OF MODES & MODE SELECTION IN THE USA

2011 APTA Modal Facts

Table 5: Unlinked Passenger Trips and Passenger Miles by Mode, Millions
Report Year 2011

Mode of Service	Passenger Trips		Passenger Miles	
	Millions	Percent	Millions	Percent
Bus	5,191	50.3%	20,408	36.4%
Bus Rapid Transit	6	0.1%	23	< 0.1%
Commuter Bus	37	0.4%	984	1.8%
Commuter Rail	466	4.5%	11,427	20.4%
Demand Response	191	1.9%	1,580	2.8%
Ferryboat	80	0.8%	416	0.7%
Heavy Rail	3,647	35.3%	17,317	30.9%
Hybrid Rail	6	0.1%	70	0.1%
Light Rail	436	4.2%	2,203	3.9%
Other Rail Modes (a)	44	0.4%	47	0.1%
Publico	39	0.4%	172	0.3%
Streetcar	43	0.4%	96	0.2%
Transit Vanpool	34	0.3%	1,176	2.1%
Trolleybus	98	0.9%	160	0.3%
Total All Modes	10,319	100.0%	56,077	100.0%

(a) Aerial tramway, automated guideway transit, cable car, inclined plane, and monorail.
Unlinked Passenger Trips by Mode data from 1902 through 2011 can be found in the *2013 Public Transportation Fact Book,*

Source: APTA, 2013, Public Transportation Fact Book

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2011 APT

Table 4: 50 Urbanized Areas with the Most Transit Travel, Ranked by Unlinked Passenger Trips, Passenger Miles, and Population, Report Year 2011 (Thousands)

Urbanized Area	Unlinked Passenger Trips (a)		Passenger Miles (a)		Population (2000 Census) (b)	
	Thousands	Rank	Thousands	Rank	Number	Rank
New York-Newark, NY-NJ-CT	4,099,710.1	1	22,390,728.0	1	18,351,295	1
Los Angeles-Long Beach-Anaheim, CA	661,690.9	2	3,349,642.6	3	12,150,996	2
Chicago, IL-IN	646,553.7	3	4,155,051.9	2	8,608,208	3
Washington, DC-VA-MD	478,463.9	4	2,501,038.6	5	4,586,770	8
San Francisco-Oakland, CA	423,007.3	5	2,569,271.9	4	3,281,212	13
Boston, MA-NH-RI	389,337.6	6	1,928,834.8	6	4,181,019	10
Philadelphia, PA-NJ-DE-MD	381,096.7	7	1,838,441.3	7	5,441,567	5
Seattle, WA	193,438.6	8	1,273,315.7	8	3,059,393	14
Miami, FL	160,648.9	9	963,376.5	9	5,502,379	4
Atlanta, GA	149,556.1	10	894,719.9	10	4,515,419	9
Portland, OR-WA	112,004.0	11	488,336.6	16	1,849,898	24
Baltimore, MD	110,316.1	12	725,607.6	11	2,203,663	19
San Diego, CA	98,292.4	13	584,890.1	12	2,956,746	15
Denver-Aurora, CO	97,933.8	14	574,681.6	13	2,374,203	18
Minneapolis-St. Paul, MN-WI	93,915.3	15	468,719.2	17	2,650,890	16
Houston, TX	81,455.2	16	540,968.1	14	4,944,332	7
Urban Honolulu, HI	75,068.2	17	420,625.8	18	802,459	(a)
Dallas-Fort Worth-Arlington, TX	71,874.2	18	499,557.4	15	5,121,892	6
Phoenix-Mesa, AZ	68,593.7	19	334,083.8	19	3,629,114	12
Pittsburgh, PA	65,585.7	20	267,372.9	24	1,733,853	27
San Juan, PR	62,861.2	21	289,217.1	22	2,148,346	21
Las Vegas-Henderson, NV	56,686.1	22	211,343.9	27	1,886,011	23
Detroit, MI	50,668.6	23	267,511.3	23	3,734,090	11
Cleveland, OH	46,960.4	24	208,549.7	28	1,780,673	25
Milwaukee, WI	46,568.2	25	154,785.8	32	1,376,476	35
St. Louis, MO-IL	45,503.8	26	306,165.8	20	2,150,706	20
San Antonio, TX	45,493.5	27	211,928.6	25	1,758,210	26
San Jose, CA	42,491.8	28	211,365.1	26	1,664,496	29
Salt Lake City-West Valley City, UT	40,487.6	29	301,728.0	21	1,021,243	42
Austin, TX	34,740.3	30	150,991.5	33	1,362,416	37
Sacramento, CA	30,292.0	31	165,398.2	29	1,723,634	28
Tampa-St. Petersburg, FL	29,342.4	32	163,408.2	30	2,441,770	17
Orlando, FL	28,023.2	33	156,698.0	31	1,510,516	32
Buffalo, NY	27,437.7	34	94,764.0	40	935,906	46
Charlotte, NC-SC	27,412.8	35	139,614.2	34	1,249,442	38
New Orleans, LA	24,905.4	36	78,952.2	43	899,703	49
Riverside-San Bernardino, CA	23,504.1	37	131,338.2	35	1,932,666	22
Cincinnati, OH-KY-IN	22,820.0	38	120,979.5	36	1,624,827	30
Providence, RI-MA	21,167.5	39	92,741.5	41	1,190,956	39
Tucson, AZ	20,227.8	40	75,306.8	45	843,168	(a)
Columbus, OH	19,023.9	41	73,275.8	48	1,368,035	36
Rochester, NY	17,675.2	42	57,877.3	(a)	720,572	(a)
Hartford, CT	16,912.6	43	103,304.2	38	924,859	47
Kansas City, MO-KS	16,810.1	44	74,431.1	46	1,519,417	31
Virginia Beach, VA	16,543.4	45	110,838.1	37	1,439,666	34
El Paso, TX-NM	16,242.3	46	79,217.7	42	803,086	(a)
Fresno, CA	16,006.1	47	37,496.6	(a)	654,628	(a)
Madison, WI	15,192.9	48	55,133.6	(a)	401,661	(a)
Louisville/Jefferson County, KY-IN	15,112.8	49	57,927.1	(a)	972,546	43
Durham, NC	14,707.8	50	65,540.6	49	347,602	(a)
Albuquerque, NM	13,380.5	(a)	102,267.1	39	741,318	(a)
Jacksonville, FL	12,639.2	(a)	74,227.6	47	1,065,219	40
Nashville-Davidson, TN	9,145.4	(a)	63,489.6	50	969,587	44
Kennewick-Pasco, WA	4,841.7	(a)	76,257.8	44	210,975	(a)

Source: APTA, 2013, Public Transportation Fact Book

Largest US Agencies by Mode

Largest Bus Agencies (Unlinked Pax Trips):

1. NYCT
2. LA County MTA
3. CTA (4 for pax miles)
4. SEPTA (5 for pax miles)
5. NJ Transit (3 for pax miles)

Largest Heavy Rail Agencies (Unlinked Pax Trips):

1. NYCT
2. WMATA
3. CTA (4 for pax miles)
4. MBTA (6 for pax miles)
5. BART (3 for pax miles)

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Largest US Agencies by Mode

Largest Commuter Rail (Unlinked Pax Trips):

1. Long Island Railroad
2. NJ Transit
3. MetroNorth
4. Metra (Chicago)
5. MBTA

Largest Light Rail (Unlinked Pax Trips):

1. MBTA
2. MUNI (San Fran)
3. LA County MTA
4. TriMet (Portland)
5. San Diego

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New Diversity of Transit Modes

- More rail being constructed; since 1970:
  - 7 new heavy rail systems constructed (BART, WMATA, MARTA, Baltimore, Miami, LA, San Juan)
  - Nearly 20 cities opened or are constructing new LRT systems
- Resurgence in streetcars and tramways after decades of elimination
- Buses traditionally non-priority
  - Buses carry 60% of transit passenger trips
  - Mostly transit captive
  - BRT is changing this

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Mode Selection

- **Systems Approach:** Cities require multiple modes integrated and working together for the highest ridership

- **Choice of modes depends on many factors**, including life cycle costs, LOS, economy, impact on surrounding, passenger attraction and livability

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Critical Transportation Issues

…many solved by Public Transportation!

- Congestion
- Energy / Environment
- Equity
- Safety
- Health
- Land Use / Availability
- Aging Population
- Community

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Worth achieving these goals, but many issues need to address

BENEFITS AND CHALLENGES

Congestion

Exhibit B-30. Delay Increase if Public Transportation Service Were Eliminated – 439 Areas

Population Group and Number of Areas	Population Group Average Annual Passenger-miles of Travel (million)	Delay Reduction Due to Public Transportation	
		Hours of Delay (million)	Percent of Base Delay
Very Large (15)	2,784	671	24
Large (31)	179	68	7
Medium (33)	51	12	4
Small (22)	19	3	3
101 Area Total	49,427	754	20
Other Areas (338)	5,970	30	5
All Areas	55,397	784	16

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Energy / Environment

- In 2005, Public transportation reduced CO2 emissions by 6.9 million metric tones
- 340 million gallons of gasoline saved

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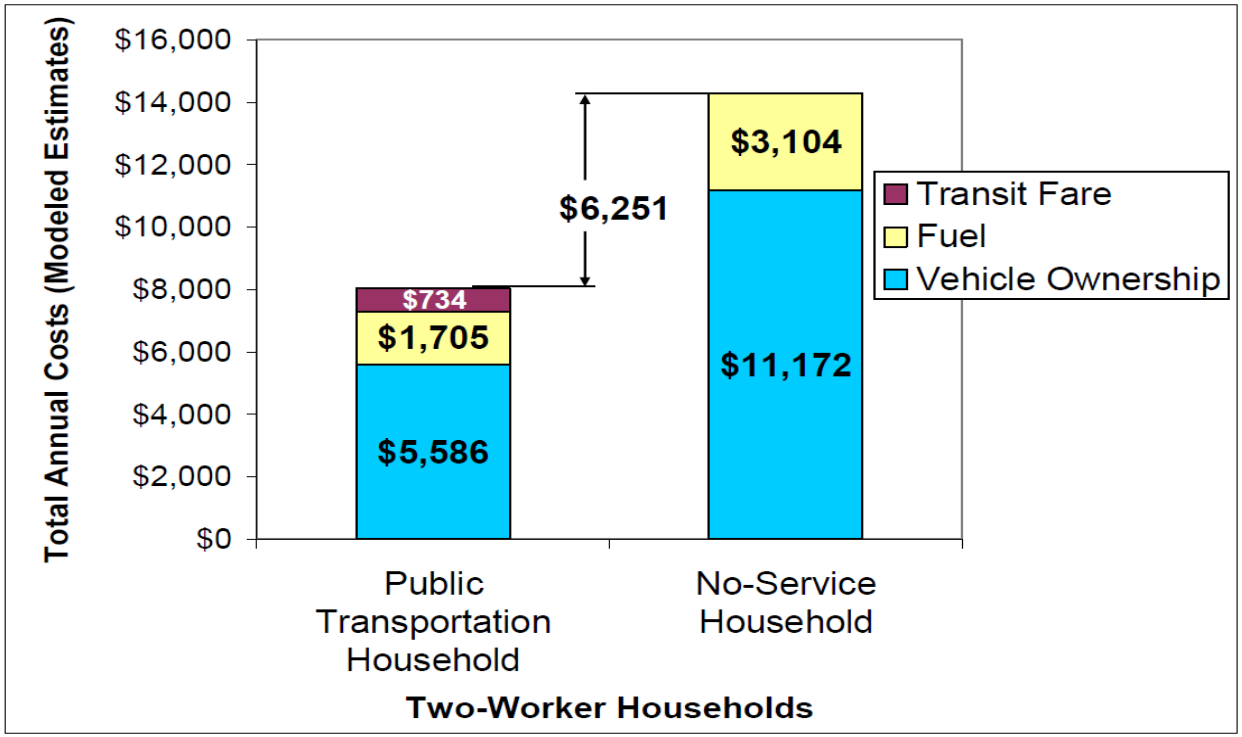
Equity

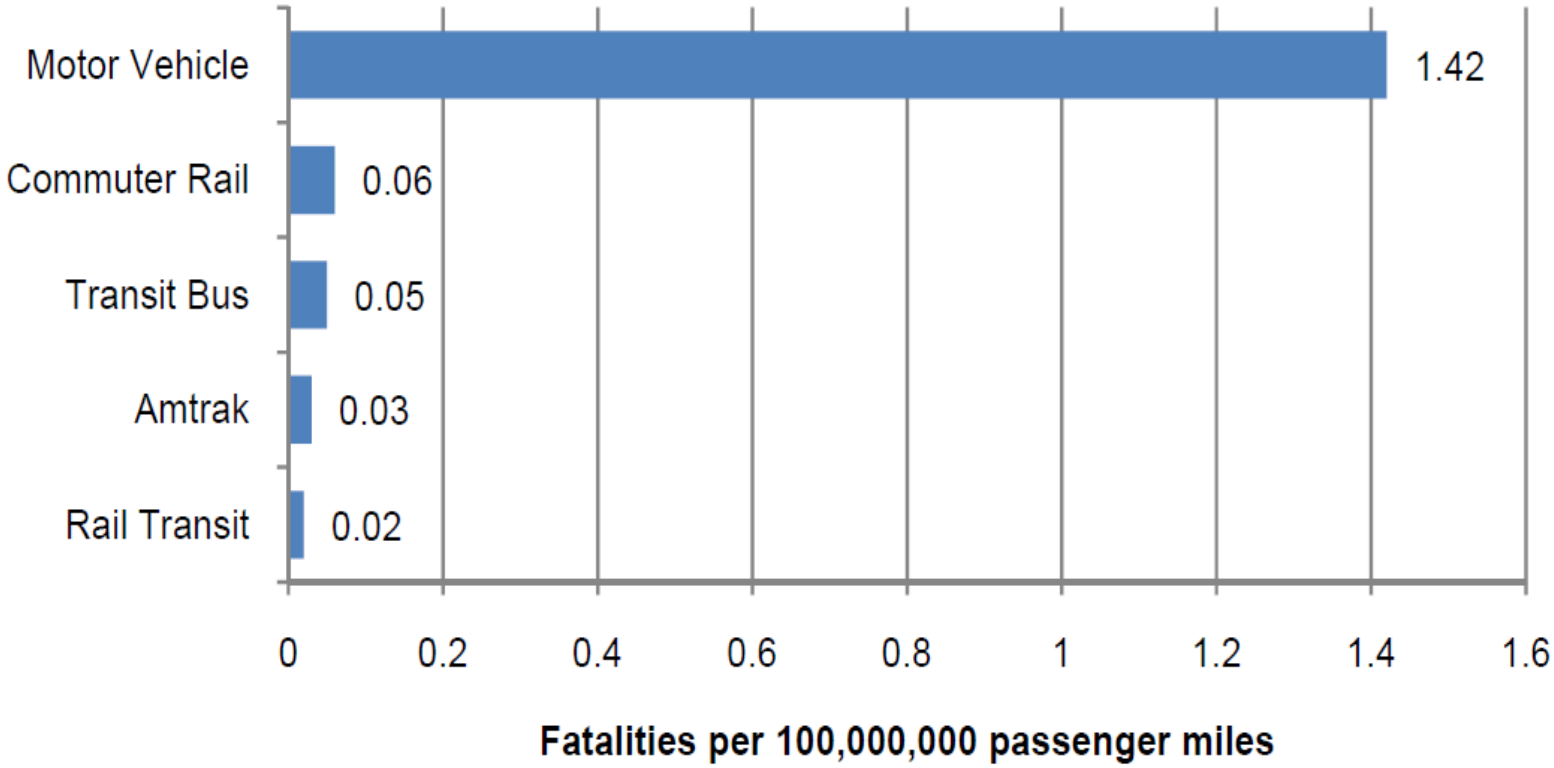
Figure 4. Total Modeled Savings for Two-Worker Households With and Without Public Transportation Service



Data based on AAA estimates of average annual vehicle ownership costs for 2006, ICF analysis of NHTS 2001 data on driving behavior, and average annual transit fares from APTA for 2004.

Safety

Figure 14: Passenger Fatality Rates: 2003-2008



Accessibility

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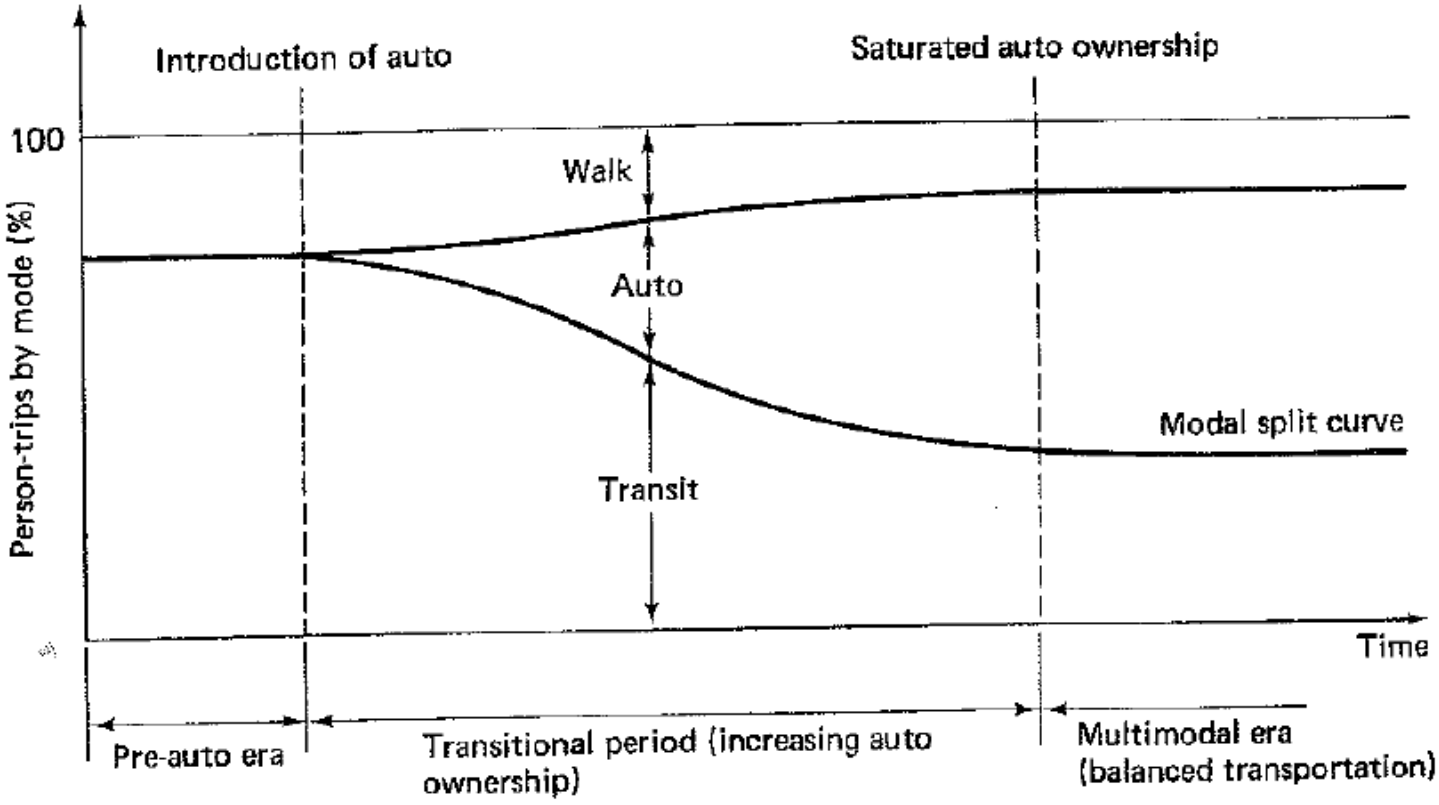
Modal Split Change



Solving problems…

So, transit solves most of these problems.

Yet, we aren't using transit.

Why?

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Solving problems…

1. Auto traffic no regulated

2. Integration & regulation of transit lacking

3. Planning & organization limited

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Make the mode fit the service or the service fit the mode:

WHAT DOES GOOD TRANSIT MEAN?

Discussion

- Bogota BRT
  - Function
  - Family
  - Characteristics

Elements of Good Transit Service

7 Demands of Useful Service

It takes me ***where*** I want to go.

It takes me ***when*** I want to go.

It is a good use of my ***time***.

It is a good use of my ***money***.

It ***respects*** me.

I can ***trust*** it.

It gives me ***freedom*** (to change my plans).

"Human transit": Adapted from Walker (2012)

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Discussion

7 Demands of Useful Service

It takes me ***where*** I want to go.	It takes me ***when*** I want to go.	It is a good use of my ***time***.	It is a good use of my ***money***.	It ***respects*** me.	I can ***trust*** it.	It gives me ***freedom*** (to change my plans).

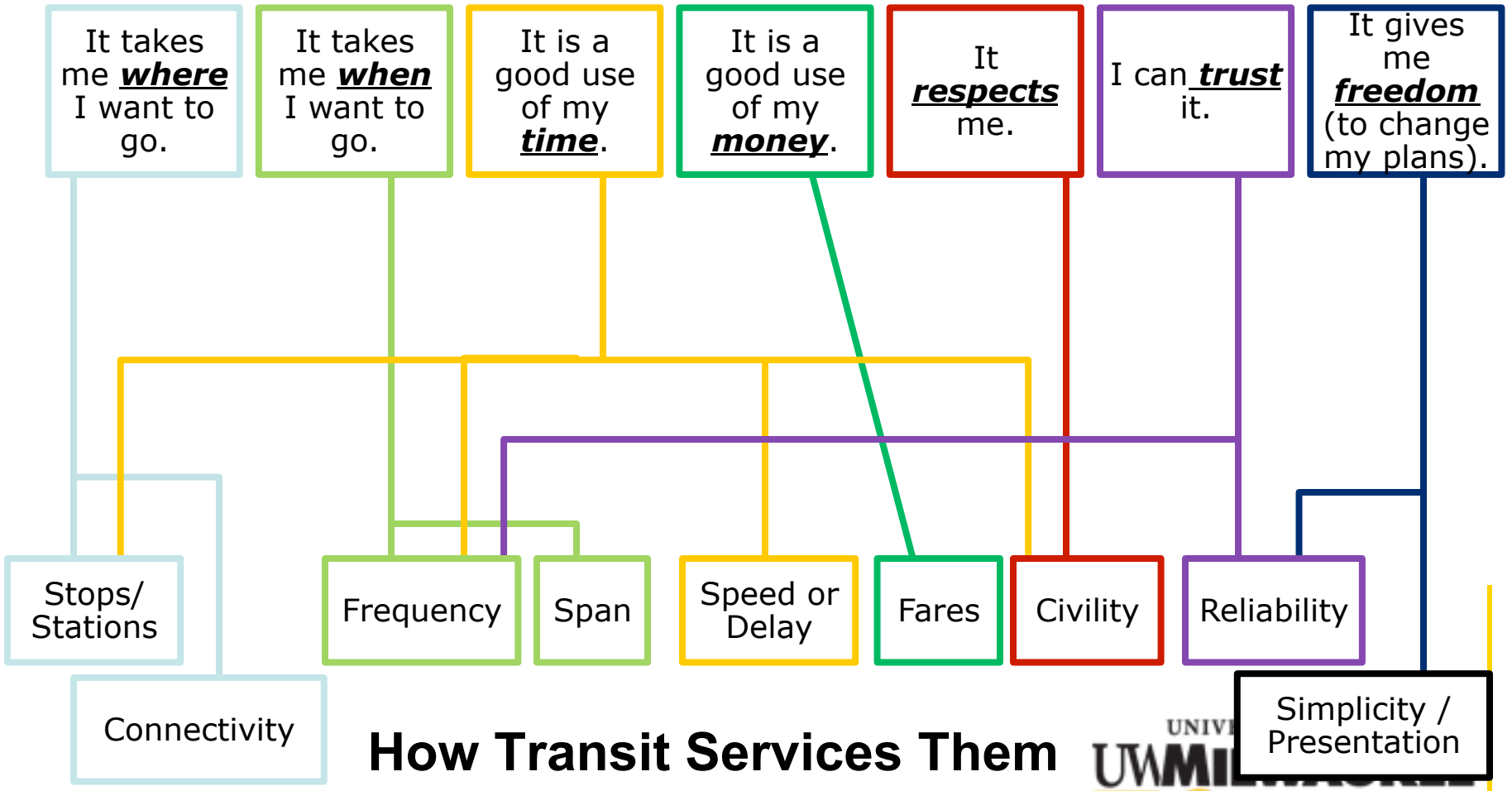
How Transit Services Them

Stops/ Stations	Frequency	Span	Speed or Delay	Fares	Civility	Reliability
Connectivity						Simplicity / Presentation

Adapted from Walker (20:

Elements of Good Transit Service

7 Demands of Useful Service



How Transit Services Them

Adapted from Walker (20

Conclusions

- Centuries of overcoming technological problems, but issues still exist

- Transit can help with
  - Congestion
  - Energy / environment
  - Equity
  - Safety
  - More

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Conclusions

- Yet transit usage is low
  - Auto traffic not regulated
  - Transit suffers from improper planning, design and operations
- Thus the need for this course
- Make the mode fit the service instead of the service fit the mode – rest of course focuses on service

Make the mode fit the service instead of the service fit the mode:

REST OF COURSE FOCUSES ON SERVICE

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HW1: paper review (see D2L guideline)

- TRB 2017: topics related to public transportation (http://amonline.trb.org/)
- ONE page review
  - Description: research objectives, flowchart/ diagram, models, algorithms, case study, proposed contributions, future extension
  - Comments:
    - Introduction (including thesis statement)
    - Specific comments (*pros and cons*)
      - argument/piece of evidence/theme
    - Overall comments
      - ties together, summarizes, broader perspective